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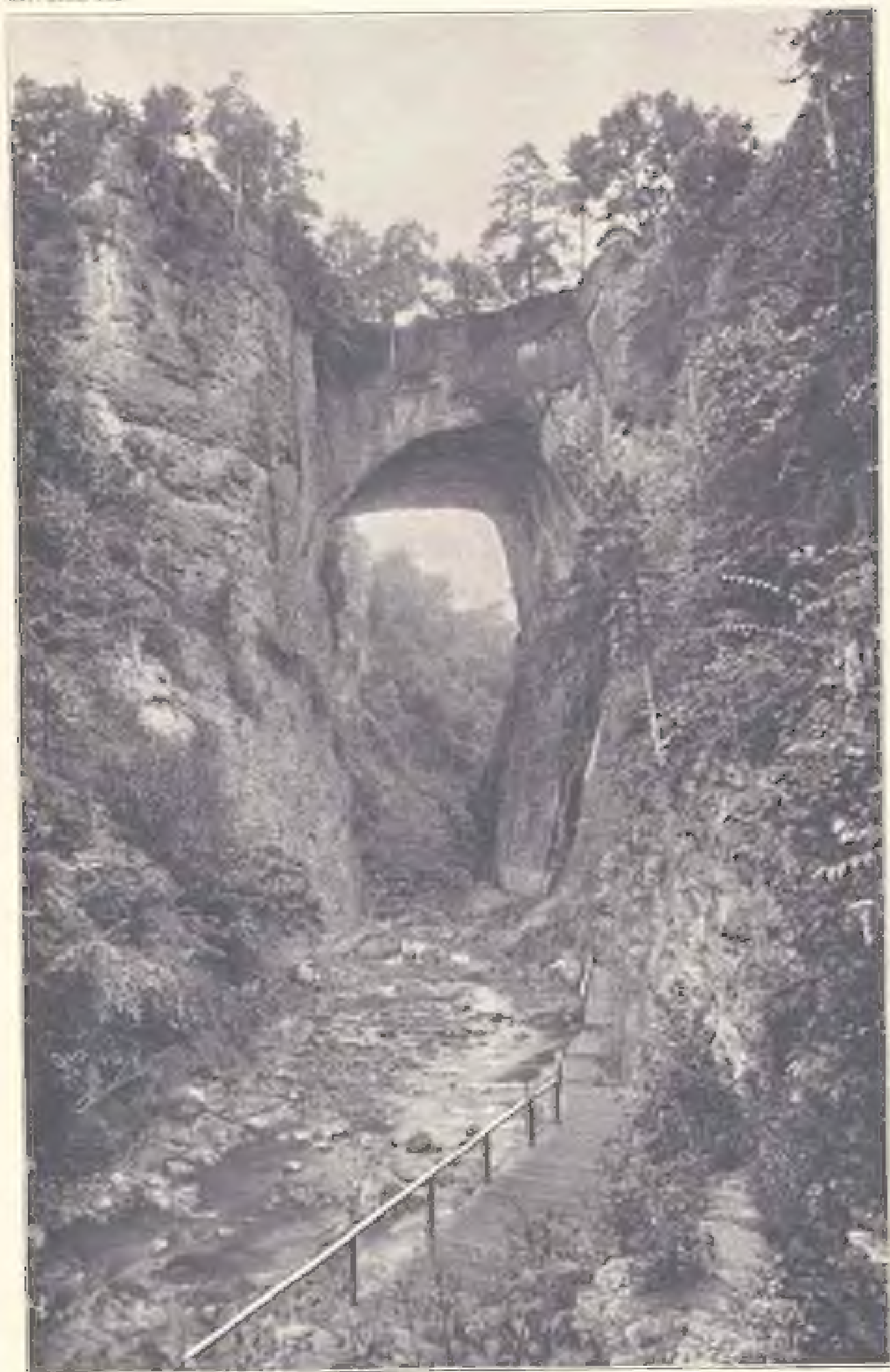


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NATURAL BRIDGE, VIRGINIA.

THE  
NATIONAL GEOGRAPHIC MAGAZINE

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THE NATURAL BRIDGE OF VIRGINIA

BY

CHARLES D. WALCOTT

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The Natural Bridge of Virginia is one of those striking geographic features of America which, like Niagara falls and many other natural features, will in time disappear under the action of the agencies of erosion. The same forces that created, will ultimately destroy them. In the case of Niagara, the rate of wear of the platform over which the water rushes has been measured, and the rate of retreat of the falls of the stream is known. Natural bridge is slowly but surely wearing away, and it appears to be desirable to record by photographic and notes the present condition of the bridge as a means of determining in the future the changes that occur from time to time. For this purpose a set of photographs, with notes taken in 1891, have been placed in the library of the United States Geological Survey.

The present article includes a few observations on the origin and the present condition of the bridge. The accompanying view (forming plate 21) is one looking northward through the arch, and it accurately represents the condition of the bridge and canyon at the time it was taken. It may be that a more detailed description, with a full series of views, will be published in the future.

During the field season of 1891 I studied the rocks exposed along the channel of Cedar creek, a small tributary of the James river in Rockbridge county, Virginia. The first strata

not with in passing up from the river are highly inclined limestone and shales of middle or upper Cambrian age. These are succeeded by the massive Knox dolomites, which are nearly vertical or inclined slightly westward. A few hundred feet below Natural bridge the westward dip decreases very rapidly, and at the bridge the beds are nearly horizontal, while a short distance above they are rising westward and dipping eastward toward the bridge at an angle of  $5^{\circ}$  to  $10^{\circ}$ . This increases to  $20^{\circ}$  to  $25^{\circ}$  higher up the stream.

A diagrammatic section of the rocks cut through in the canyon of Cedar creek gives the outline shown in figure 1. The bridge is at *A*, Lane falls at *B*, and James river at *C*. No attempt is made to show the depth of the canyon or gorge through which Cedar creek flows.

It is not supposed that the present Cedar creek began to wear its channel across the edges of the upturned beds from *B* to *C* when the present topographic features were established; on the contrary, it began its work long before, under conditions



FIGURE 1.—Outline of Strata at Natural Bridge.

and in rocks that have since disappeared in the general erosion of the surrounding country. The course of the stream was determined by circumstances connected with the life history of James river. When the latter obtained a new lease of active life and lowered its channel through the Blue ridge, Cedar creek began to cut down its bed in the peneplain and to prepare the way for the possibility of the existence of an arch over its channel.

The general mode of formation has long been described for this and other natural rock bridges. In this case in detail it is considered to be as follows: Cedar creek was engaged for a considerable period in excavating the gorge from the James river to a point not far below the present site of the bridge, where a fall appears to have existed, the summit of which was not far if at all below the present level of the top of the bridge. About this time the water found a subterranean passage in the limestone farther up the stream than the present site of the bridge, and through this it flowed and discharged beneath the brink of the falls.



The passage gradually enlarged until all the waters of the creek passed through it and the bridge began its existence. What the length of this subterranean passage was is a matter of conjecture; it may have been one hundred or several hundred feet. All of its roof has disappeared except the narrow span of the bridge, and the abutting walls have been worn back by erosion until the gorge or canyon is much wider than at the bridge. The bridge is massive and strong, and the supporting walls rise in solid, almost unbroken, mural faces to the spring of the arch, nearly 200 feet above the bed of Colar creek, as clearly shown in the accompanying plate (which is reproduced mechanically from a photograph taken by the author).

The position of the massive layers of limestone at the center of the low synclinal gives them power to resist erosion to a much greater extent than the upturned strata above and below the bridge. The condition of the latter favors rapid disintegration, and the result is shown in the widening of the gorge. The retreating lower level of the stream is now at Lace falls, nearly a mile above the bridge. The gorge below the bridge widens out more rapidly, owing partly to the erosion caused by a small brook that enters from the north, partly to the greater period of erosion to which it has been subjected.

On the northern side opposite Palpit rock, about twenty feet west of the public road, the summit of the bridge is 200 feet above the water, and this part of the arch has a thickness of 44 feet and a span of from 45 to 50 feet. The western edge is about ten feet higher, and the eastern edge about ten feet lower than the central point.

The massive layers of limestone forming the bridge are gradually wearing away on the outer edges from the action of water and frost. If water-breaks were arranged so that the water could not flow in upon the bridge and about it from the southwestern side, and if a shed with water-tight roof were built over the arch, disintegration and destruction would be indefinitely postponed. As it is, it will be many centuries before the natural processes of erosion now at work upon and within the arch will completely break it down.

Since the preceding was written, an article has appeared in the *New York Tribune* of May 15, 1893, in which an account is given of the discovery of a passage in the limestones near Natural

bridge that extends from the plain above down to the stream below. It is described as follows:

"The passage was probably created by a stream of water finding a crevice in the limestone mountain, and by the gnawing of gases, the same causes that created the natural bridge. But it has all the appearance of design and purpose. A brief description by one who has recently seen it in the light of hundreds of candles shows at the entrance a room about twenty feet by ten, with a ceiling sixty feet in height, then a low, arched doorway into a room narrower than the former and extending forty or fifty feet up a steep flight of steps. The arches here are from fifteen to twenty feet in height, and their color a liquid blue. There are a few stalactites from the ceiling and many crystal forms on the wall. Turning here from a direct course through another arched doorway, beautifully decorated, about six feet in height, there is a round room, twenty feet in diameter and perhaps fifty feet from pit to dome. Out of the side of this springs a stone cascade, perfect as any waterfall, transparent at the lower edge, about ten feet in length and eight in breadth. As the light is thrown upon this it has all the appearance of a living waterfall. A passage under this, over a bridge leads to a labyrinth beneath wide enough for one to pass. The arch is about fifteen feet in height and the walls glisten like polished marble. These windings extend about thirty feet and open into a well-shaped room not at any point more than fifteen feet in diameter and opening, about thirty feet above, to the sky."

From the description it is evident that the passage was worn by percolating waters that found their way from the plain above to the basel level cut by the stream below, along some previously existing crevices. This process of erosion may be seen at the "Underground river" between Natural bridge and Laco falls, where a strong current of water flows through a channel in the limestone that is about ten feet above the level of Cedar creek and only exposed to view for a few feet of its length. All of the phenomena observed at Natural bridge and in the canyon of Cedar creek are repeated in many limestone regions. Sometimes they give rise to underground caverns, as at Mammoth cave, and more rarely to canyons and natural bridges. The illustration at the natural bridge is one of the finest known, and worthy of study by any one interested in geologic phenomena of the beautiful in nature.



# THE GEOGRAPHICAL POSITION AND HEIGHT OF MOUNT SAINT ELIAS

BY

DR T. C. MENDELL

*(Presented before the Society April 28, 1882)*

In connection with the survey of the boundary line between Alaska and the British Northwest Territory it became necessary to determine the geographical position of Mount Saint Elias.

Previous approximate determinations had shown that the peak of this mountain must be very near the 141st meridian, which constitutes the greater part of this boundary line, and that its distance from the seacoast must be very nearly ten marine leagues, which by treaty is to determine the position of the line in the absence of a range of mountains parallel to the windings of the coast.

It thus appeared that this peak is likely to prove of very great value as a corner-stone in this great boundary line, being at the junction of the 141st meridian and that part of the line which is so vaguely defined in the treaty.

The execution of the work in the immediate vicinity of the mountain was intrusted to assistants J. E. McGrath and J. Henry Turner, whose previous explorations and long residence in the interior of Alaska in connection with the determination of the 141st meridian are well known to the members of this Society.\*

The complete reduction of the observations made has not yet been accomplished, but enough has been done to show the geographical position of the mountain peak within a very small error, and the Society will probably be interested in the preliminary results of this work, which are not likely to be modified sensibly by the completed calculations.

The fieldwork was executed during the summer of 1882.

\* An account of their work appears in *Nat. Geog. Mag.*, vol. iv, 1882, pp. 177-197.

The party was carried to the working ground by the Coast Survey Steamer *Harbor*, in command of Captain Harbor, who personally took great interest in the work and facilitated its successful performance very much, taking a very important part, in fact, in the determination of the difference of longitude between Sitka and the astronomical station at Yakutat bay. In the absence of telegraphic connection with any of these points, a series of chronometric journeys was made between Tacoma, which is near one of the telegraph longitude stations of the great system of the United States Coast and Geodetic Survey, and Sitka, which has been fixed as the base of the longitude work throughout the territory of Alaska.

Contemporaneously a series of journeys was made between Sitka and the astronomical station at Yakutat bay by the Coast Survey Steamer *Harbor*, and by these two loops the longitude of the stations was connected with that of the telegraphic system of the United States. Time observations at Tacoma and the comparison of chronometers at that point were under the direction of assistant J. F. Pratt. Six complete chronometer tours from Tacoma to Sitka and return were made on board of the Steamer *Quinn*, the chronometers being in charge of Mr. T. D. Davidson, of San Francisco; this link having also been taken in by the *Harbor* chronometers on her way to and from the field, seven complete journeys are available between Tacoma and Sitka. Six complete journeys between Sitka and the astronomical station at Yakutat bay were made. An astronomical station was established at Sitka under the direction of sub-assistant Fremont Morse, who had charge of time-observations and the comparison of both sets of chronometers on reaching that point. Seven chronometers made the journeys between Tacoma and Sitka, and the same number between Sitka and Yakutat bay. The astronomical station at the latter place was in charge of assistant J. Henry Turner. The connection of this station trigonometrically with the summit of Mount Saint Elias was under the direction of assistant J. R. McGrath. The astronomical station was on the southern side of Yakutat bay, and the measured base line from which the triangulation was developed was on the northern side. The length of this line was a little less than 7/80 metres, or about four and a half miles. The scheme of triangulation is shown on the accompanying sketch (figure 2). The latitude of the astronomical station was determined by











[illegible]

Further, the fact that a new group of people is being added to the ranks of the unemployed suggests that the economy is not doing as well as it should. The fact that the unemployment rate is rising for the third month in a row is a clear sign of economic trouble.

[illegible]

With our New England students eventually in a good position, about 1900, the first large-scale population movement in the southern part of the state in Massachusetts was a substantial exodus to New England and the Midwest, leaving a relatively empty rural landscape.

[illegible]

The results of the 1997 election were a political earthquake in Nevada. The voters elected a Democrat to the governor's office, a Democrat to the state legislature, and a Democrat to the state senate. The results of the 1997 election were a political earthquake in Nevada. The voters elected a Democrat to the governor's office, a Democrat to the state legislature, and a Democrat to the state senate.

\* Vignettes of the 100 most famous people, to be found in the year 2000 and their life story, still to be seen.







The 1 year of operation from 1998 to 1999

[illegible][illegible]





While we must not lose sight of the fact that the world is a better place than it was a few years ago, we must not forget that the world is still a very long way from being a better place than it was a few years ago. The world is still a very long way from being a better place than it was a few years ago. The world is still a very long way from being a better place than it was a few years ago.

[illegible]

1)  $\alpha, \beta, \gamma, \delta \in \mathbb{R}$  mit  $\alpha + \beta + \gamma + \delta = 2\pi$  und  $\alpha, \beta, \gamma, \delta \in (0, \pi)$  sind.

# AN UNDESIRABLE DISTANTION OF THE NORTH COAST OF AFRICA

*Presented before the Senate on 10th May 1850*

LESLIE MATHIAS BAKER

The question of the propriety of a political union between certain  
 western European states and the north-western coast of Africa has  
 not hitherto been the subject of discussion in the House of  
 Commons. The question of the propriety of a political union between  
 the United Kingdom and the north-western coast of Africa has  
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 western European states and the north-western coast of Africa has  
 not hitherto been the subject of discussion in the House of  
 Commons.

\* A letter from a private individual to the Secretary of the Foreign  
 Office, dated 10th May 1850, is printed in the Appendix to the  
 Report of the Committee of the House of Commons on the subject of  
 the proposed union of the United Kingdom and the north-western  
 coast of Africa.

There was not a net in the net house, and the fish were taken by hand. The fish were flat as a pancake, but when they were picked up they were S-shaped, and when they were picked up they were as flat as a pancake. The fish were as flat as a pancake, and when they were picked up they were S-shaped.

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[illegible][illegible][illegible][illegible]

The first two steps are the same as in the previous example. The third step is to find the value of  $\lambda$  that minimizes the function  $f(\lambda)$ . This is done by setting the derivative of  $f(\lambda)$  with respect to  $\lambda$  equal to zero and solving for  $\lambda$ . In this case, the derivative is  $f'(\lambda) = 2\lambda - 1$ , and setting it equal to zero gives  $\lambda = 0.5$ .

It is also necessary to be able to put the patient's story in context. We must not lose sight of the possibility of a patient's having been exposed to a toxic agent, or of the possibility of a patient's having been involved in an accident, or of the possibility of a patient's having been exposed to a disease. It is also necessary to be able to put the patient's story in context. We must not lose sight of the possibility of a patient's having been exposed to a toxic agent, or of the possibility of a patient's having been involved in an accident, or of the possibility of a patient's having been exposed to a disease.

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There had been a lot of other cases but I thought I would mention the case of the first person to have been killed in the area. The person had been killed in the area of the first person to have been killed in the area. The person had been killed in the area of the first person to have been killed in the area.

[illegible]

**1) 1970-1980**      **2) 1981-1990**

Mr. De Krom was our "Apostle" as you have called him, and I think that the  
 spirit of "Union" are expressed in interesting and varied manner,  
 and relations with Mr. De Krom in the belief that he is equal to  
 the position as a leader, poet, lawyer, and Mr. De Krom.

Other studies have indicated that the proportion of the population with a history of a stroke is increasing. In 1997, the prevalence of stroke was 1.1% in the United States, and this figure is projected to increase to 2.1% by the year 2010. The increase in the prevalence of stroke is due to a number of factors, including an increase in the incidence of stroke, an increase in the survival of stroke survivors, and an increase in the age of the population. The increase in the incidence of stroke is due to a number of factors, including an increase in the incidence of risk factors for stroke, such as hypertension, diabetes, and smoking, and an increase in the incidence of stroke in younger populations. The increase in the survival of stroke survivors is due to a number of factors, including an increase in the availability of medical care and an increase in the effectiveness of medical treatments. The increase in the age of the population is due to a number of factors, including an increase in life expectancy and an increase in the number of people living in the United States.

















[illegible][illegible][illegible]

Thank you for being so patient and generous that you'll be able to get your question answered. I have a question for you. I was told that the best way to get a good price on a car is to wait until the end of the month and then go to the dealership. Is this true? I was told that the best way to get a good price on a car is to wait until the end of the month and then go to the dealership. Is this true?

[illegible][illegible]

The following are the names of the persons who have been appointed to the various positions in the various departments of the Government of the State of New York, for the year 1900:

There are a few other things that I would like to mention about the trip. First, I was very lucky to have a great guide, John, who was very knowledgeable about the area and the people. He was also very friendly and made the trip very enjoyable. Second, the weather was perfect. It was not too hot and not too cold. The food was also very good. I was very happy to go on this trip and I would like to go back again sometime.

1996). In the case of the *Phragmites* marsh, the *Phragmites* marsh was the only marsh type that was not significantly different from the other marsh types.





# The World's Great Lakes

1

List of the most important lakes and rivers.

Rank	Year	Name	Area (sq. mi.)
1	1881	Superior Lake, U.S.A.	31,344
2	1881	Michigan Lake, U.S.A.	23,442
3	1881	Illinois Lake, U.S.A.	21,246
4	1881	St. Lawrence River, U.S.A. & Canada	18,460
5	1881	Ontario Lake, U.S.A.	17,340
6	1881	U.S.A. Lake, U.S.A.	16,440
7	1881	U.S.A. Lake, U.S.A.	15,440
8	1881	U.S.A. Lake, U.S.A.	14,440
9	1881	U.S.A. Lake, U.S.A.	13,440
10	1881	U.S.A. Lake, U.S.A.	12,440
11	1881	U.S.A. Lake, U.S.A.	11,440
12	1881	U.S.A. Lake, U.S.A.	10,440
13	1881	U.S.A. Lake, U.S.A.	9,440
14	1881	U.S.A. Lake, U.S.A.	8,440
15	1881	U.S.A. Lake, U.S.A.	7,440
16	1881	U.S.A. Lake, U.S.A.	6,440
17	1881	U.S.A. Lake, U.S.A.	5,440
18	1881	U.S.A. Lake, U.S.A.	4,440
19	1881	U.S.A. Lake, U.S.A.	3,440
20	1881	U.S.A. Lake, U.S.A.	2,440
21	1881	U.S.A. Lake, U.S.A.	1,440
22	1881	U.S.A. Lake, U.S.A.	1,440
23	1881	U.S.A. Lake, U.S.A.	1,440
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97	1881	U.S.A. Lake, U.S.A.	1,440
98	1881	U.S.A. Lake, U.S.A.	1,440
99	1881	U.S.A. Lake, U.S.A.	1,440
100	1881	U.S.A. Lake, U.S.A.	1,440

In view of the powerful training influence exercised by great cities upon the progress and welfare of the world, the extent of the dominating force exerted more than one-half of the entire hemisphere are either populated by English-speaking races or are under their control. Of these I have indicated two new colonies, Canada, two old ones, such as China, two in Egypt, six in England, four in India, two in Ireland, two in Scotland, one in Singapore and several others in the United States.

It is not the purpose of this study to investigate the reasons why participants during the 2008 election gave more favorable ratings for presidential candidates than for local, state, or congressional candidates, nor was it planned that the study would suggest transportation and a moderately high crime rate are the most important factors in whether they are not the president or in Congress. As such, one can not very readily remark that the local and state crime rates may be an "explanatory factor" and that the local law enforcement are for and not against the president or Congress. However, by having a greater number of large cities and states, the study is an attempt to represent the world as it is. In the parts of Europe and Asia that where there are not local presidential precinct there is one city of 10,000 or more and a total of about over 200,000 population. In these areas there are only one

And, not few examples of the popularities in the world are the product of the age, as is indicated by the fact that in the beginning of this century the United States had not only a few hundred thousand inhabitants, while now it has twenty-eight millions, but not only that it has twenty-five

## REYNOLDS'S VOLCANO

1861-1911

*Presented before the Academy April 29, 1892*

That you speak to me as in Alaska. There was no eruption at Reynolds in the year 1881, and not two since, and the same has been the case with a great number of the eruptions of active volcanoes in Alaska. In our own country, especially of Alaska, there may be some doubt whether living volcanoes exist.

It is well known that the greatest volcanic region in the world is in the mountainous part of our own

continent. The whole mountainous part of the country is full of extinct and living peaks of the Tertiary period, and there is still a considerable number of cones which can hardly be known as extinct.

Properly speaking, volcanoes may be seen in western Nevada, but the large majority of the area of the State is without any. There is some doubt, however, about the Mount Baker eruption in the State of Washington.

Volcanic eruptions of various kinds have taken place in this country as early as with a full fall of snow. Professor Fuchs, of the United States Geological Survey, has in 1878-1881 reported eruptions of Mount Baker in 1851, 1854, and 1860. These reports are based on observations made by the Indians, who say that they have not been recollected by a single word of the Indians.

The Japanese, of San Francisco, reported that the volcano of Mount St. Helens was active in 1800, 1810, and 1820.

But at the present time the only report east of Lassen peak, California, is that the lava was seen to flow out of the front of the lava at the time of the eruption. He visited the locality







*(Letter written from and to the co)*

largest tree ever discovered came up of less than 100 years  
old within the area, but which can be come to get large numbers  
of trees be done 200 years ago

On the whole, it would seem probable, therefore, that the  
youngest volcano south of Alaska is not the one of course the  
one of course of large peaks as we are supposed, but as it is  
likely to prove to be one of the best, in Washington.







